Concurrent and simultaneous polydrug use among young Swiss males: use patterns and associations of number of substances used with health issues

Baggio, Stéphanie ; Studer, Joseph ; Mohler-Kuo, Meichun ; Daeppen, Jean-Bernard ; Gmel, Gerhard

Abstract: Abstract Background: Simultaneous polydrug use (SPU) may represent a greater incremental risk factor for human health than concurrent polydrug use (CPU). However, few studies have examined these patterns of use in relation to health issues, particularly with regard to the number of drugs used. Methods: In the present study, we have analyzed data from a representative sample of 5734 young Swiss males from the Cohort Study on Substance Use Risk Factors. Exposure to drugs (i.e., alcohol, tobacco, cannabis, and 15 other illicit drugs), as well as mental, social and physical factors, were studied through regression analysis. Results: We found that individuals engaging in CPU and SPU followed the known stages of drug use, involving initial experiences with licit drugs (e.g., alcohol and tobacco), followed by use of cannabis and then other illicit drugs. In this regard, two classes of illicit drugs were identified, including first uppers, hallucinogens and sniffed drugs; and then "harder" drugs (ketamine, heroin, and crystal meth), which were only consumed by polydrug users who were already taking numerous drugs. Moreover, we observed an association between the number of drugs used simultaneously and social issues (i.e., social consequences and aggressiveness). In fact, the more often the participants simultaneously used substances, the more likely they were to experience social problems. In contrast, we did not find any relationship between SPU and depression, anxiety, health consequences, or health. Conclusions: We identified some associations with SPU that were independent of CPU. Moreover, we found that the number of concurrently used drugs can be a strong factor associated with mental and physical health, although their simultaneous use may not significantly contribute to this association. Finally, the negative effects related to the use of one substance might be counteracted by the use of an additional substance.

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Stéphanie Baggio*, Joseph Studer, Meichun Mohler-Kuo, Jean-Bernard Daeppen and Gerhard Gmel

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Keywords: concurrent polydrug use; drug use pattern; mental and physical health; number of drugs used; simultaneous polydrug use.

***Corresponding author: Stéphanie Baggio,** Alcohol Treatment Center, Lausanne University Hospital CHUV, Av. Beaumont 21 bis, Pavillon 2, CH-1011 Lausanne, Switzerland, Phone: +41 21 3143951, Fax: +41 21 3140562, E-mail: Stephanie.Baggio@chuv.ch
Joseph Studer and Jean-Bernard Daeppen: Alcohol Treatment Center, Lausanne University Hospital, Lausanne, Switzerland
Meichun Mohler-Kuo: Institute of Social- and Preventive Medicine, University of Zurich, Zurich, Switzerland
Gerhard Gmel: Alcohol Treatment Center, Lausanne University Hospital, Lausanne, Switzerland; Swiss Institute for the Prevention of Alcohol and Drug Problems, Lausanne, Switzerland; Center for Addiction and Mental Health, Toronto, Ontario, Canada; and University of the West of England, Bristol, UK

Introduction

Substance use disorder represents the most prevalent form of psychopathology in young adults (1, 2). Although it is well known that single drug use is rare (3–7), there have been few studies investigating polydrug use [i.e., the ingestion of more than one drug (3)]. Indeed, polydrug use is associated with a unique set of consequences (8), including psychological morbidity/pathology (9–11), health risk behaviors (12) [e.g., HIV risk-taking (5)], difficulties engaging in drug-abuse therapy (13), and worse outcomes following drug-abuse treatment (14). Moreover, some studies indicated that the abuse of a higher number of substances was associated with more severe health outcomes (15–18).

Two forms of polydrug use were described in literature, namely, concurrent and simultaneous (19). Concurrent polydrug use (CPU) refers to the use of two or more substances within a given time period. Meanwhile, simultaneous polydrug use (SPU) is the use of two or more substances at the same time, on a single occasion (20). SPU is considered a subset of CPU (21). Furthermore, SPU was found to be a key characteristic of the substance use patterns associated with many drug users, especially teenagers and young adults (1, 22–24). Moreover, studies demonstrated that SPU posed greater health risk than CPU (21). For example, simultaneous polydrug users reported more drug use-related problems than concurrent

polydrug users (21). Those engaging in SPU also displayed more social problems/consequences, psychosocial distress (e.g., depression) (19, 20), anxiety (19), and health problems (19, 20, 25). In addition, the risk of injury, poisoning, overdose (26), or suicide (25) was higher during SPU. Similarly, SPU led to an increased likelihood for later substance-related problems among teenagers (27).

The present investigation addresses some of the limitations of earlier studies within this field. First of all, few studies compared CPU and SPU (21, 25). Second, these studies did not thoroughly investigate the impact of the number of drugs simultaneously used, a variable that reflected the level of severity of drug use in studies of CPU (15). Notably, the number of drugs used may be more important than the type of drugs used for the prediction of first suicide attempts (17). However, there may be a methodological problem when studying SPU, because it can be confounded with CPU (i.e., the more drugs people use simultaneously, the more drugs they must use concurrently). For this reason, some studies comparing SPU and CPU (21, 25) did not assess the associations of SPU with variables while controlling for CPU. Another limitation of past studies is that they focused on select substances, such as alcohol, tobacco, cannabis, and specific illicit drugs. Therefore, no previous study has investigated polydrug use patterns while considering a comprehensive list of drugs.

The aims of this study were to examine the patterns of CPU and SPU in relation to a wide variety of drugs (18 drugs) and to determine the additional associations of SPU with health (i.e., relevant outcomes identified in previous studies on polydrug use in terms of mental/physical health, social problems and consequences) following adjustment for CPU. Although this cross-sectional study did not allow us to define causality, regression models were used to test associations between health and SPU after adjusting for several factors, including CPU.

Materials and methods

Subjects

The data for this study were obtained from the Cohort Study on Substance Use Risk Factors (C-SURF). C-SURF is an ongoing, longitudinal study designed to assess substance use patterns and related consequences in young Swiss men. Enrollment took place between August 23, 2010 and November 15, 2011 in three of the six army recruitment centers located in Lausanne (French-speaking), and Windisch and Mels (German-speaking). These three centers covered 21 of 26 cantons in Switzerland, including all French-speaking cantons. In Switzerland, army service is compulsory. Thus, all young men at around 20 years of age were eligible for inclusion in the study. Our cohort was highly representative of young Swiss men. Moreover, this study was approved by the Ethics Committee for Clinical Research of the Lausanne University Medical School and followed the Helsinki declaration.

Of the 13,245 conscripts informed about the study, 7563 gave written consent to participate, and 5990 filled in the baseline questionnaire. This analysis was performed on baseline data only. The study focused on the 5636 participants who had used at least one drug during the past 12 months, including alcohol (94.1% of the sample). Subjects with missing values related to outcome variables were not considered in the analysis. Thus, the final study cohort included 5319 participants (94.4% of the sample). More information about sampling and non-response can be found in Studer et al. (28). Early respondents (responses obtained without extra effort) were compared to late respondents (those responses acquired through increased efforts, i.e., encouraging telephone calls), and non-respondents (those who answered a 5-min questionnaire on substance use during the enrollment phase of the C-SURF). Early respondents were less likely to be either substance users or heavy users in comparison to late respondents, and non-respondents showed generally higher patterns of substance use than late respondents (excluding alcohol use). Therefore, using late respondents greatly reduced the magnitude of the non-response bias, even if it was insufficient to free survey estimates from the risk of non-response bias. However, differences between respondents and non-respondents were small and significant only because of the large sample size (n=11,819).

Measures

CPU

CPU was assessed by asking participants whether they used specific drugs during the past 12 months. Each drug was coded as "used" or "non-used". The drugs included: 1) alcohol; 2) tobacco; 3) cannabis; 4) hallucinogens, magic mushrooms, psilocybin, peyote, or mescaline; 5) other hallucinogens [lysergic acid diethylamide (LSD), phencyclidine (PCP)/angeldust, 2-CB, or 2-CI]; 6) salvia divinorum; 7) speed; 8) amphetamine, methamphetamine, or amphetaminsulfate (e.g., Dexedrine, Benzedrine); 9) crystal meth (Ice); 10) poppers (amyl nitrite, butyl nitrite); 11) solvent sniffing [e.g., glue, solvent, or gas (benzin, ether, toulol, trichloroethylene, nitrous oxide, etc.)]; 12) ecstasy, 3,4-methylenedioxy-N-methylamphetamine (MDMA); 13) cocaine, crack, or freebase; 14) heroin; 15) ketamine (Special K) or DXM; 16) gamma-hydroxybutyric acid (GHB)/gamma-butyrolactone (GBL)/I-4 Butanediol (BDB); 17) research chemicals (e.g., mephedrone, butylone, or methedrone); and 18) spice or similar substances. The global CPU score was determined by summing up all the drug categories used during the past 12 months (licit and illicit drugs combined, total score from 1 to 18, each positive category counted as "1" in the total score).

SPU

The co-use of drugs was assessed by questioning participants about the drugs that they combined during the past 12 months. Specifically, individuals were asked to divulge the usual number of drugs they

used on a usual occasion ("usual SPU"), and the maximum number of drugs that they had combined ("maximum SPU"). The drug categories used for this assessment were the same as those used for CPU scoring. Two global SPU scores were determined (i.e., "usual SPU" and "maximum SPU") by summing the total drugs used (licit and illicit drugs combined, total score from 0 to 18, each category counted as "1" for the total scores).

Mental, social, and physical factors

Anxiety and aggressiveness

In order to assess anxiety and aggressiveness, two subscales from the Zuckerman-Kuhlmann Personality Questionnaire (ZKPQ-50-cc) (29) were used, namely, neuroticism/anxiety and aggression/hostility. The participants were asked to agree or disagree with each statement. A mean score was computed for each subscale (anxiety: α=0.73, aggressiveness: α=0.56).

Depression

Depression level was determined using the Major Depressive Inventory (MDI) from the International Statistical Classification of Diseases and Related Health Problems (ICD-10) by the World Health Organization (WHO) (30, 31). This is a 10-item questionnaire that screens answers on a 6-point scale from "never" (0) to "all the time" (5). A mean score was computed (α=0.91). A continuous scale (ranging from 0 to 50) was used instead of a cutoff value in order to better capture variability across the range of depression symptoms.

Mental and physical health

The Short Form Health Survey (SF-12) was used to assess mental and physical health (32) based on two subscales, namely, mental/social health and physical health. The subscale scores were computed according to the standard system, yielding two composite scores, which ranged from "0" (health problem) to "100" (no health problem). SF-12 primarily covered sadness, nervousness, and depression.

Consequences

A total of 15 consequences were selected from standard instruments (33–36). However, these items were not explicitly substance related, and resulted in different associations compared with consequences that can be causally attributed to substances. Included items were related to social, personal, and health consequences. Each consequence was coded "0" if it had not occurred in the past 12 months and "1" if it had taken place at least once during the past 12 months. Two mean scores of consequences were computed. The first score was related to social consequences, including physical fights, problems with family/friends, poor performance at school/work, theft, trouble with the police, regretted sexual intercourse, or damage to property. The second score was related to health consequences, including accident/injury, admittance to an emergency department, attempted suicide, need for medical treatment, overnight stay in a hospital, outpatient surgery, and treatment of an accident/injury in an emergency department.

Analyses

To examine CPU and SPU patterns, descriptive cross tables were created for each kind of polydrug use (CPU, usual SPU, and maximum SPU). The associations of SPU with the aforementioned health factors were subsequently tested using linear regression analyses. However, although linear regression analyses were performed, a causal relationship between SPU and health factors was not assessed. The aim of this study was to investigate their actual relationship. First, two models were created to test the association of SPU alone (usual SPU and maximum SPU) with the 7 factors considered as dependent variables (unadjusted models). We then took into account the effect of CPU (adjusted models). As SPU is part of CPU, we initially conducted linear regression analyses, with CPU as the predictor and SPU (usual SPU and maximum SPU) as the dependent variable, and then recorded the residual factors for each model. The residual factors were used as independent variables when analyzing each of the 7 health-related variables. This allowed us to extract the unique variance of SPU and test the "pure" association of SPU with health. Holm-Bonferroni correction (37) was used, and statistical significance was set at 0.05. All analyses were conducted using SPSS software (version 20). Standardized regression slopes (β) were also presented instead of raw slopes to allow comparison between unadjusted and adjusted SPU with a scale-free estimation (38).

Results

Descriptive analysis

Prevalence rates and descriptive statistics are shown in Tables 1 and 2. On average, the participants used 2.07 drugs for CPU (SD=1.48), 1.46 drugs for usual SPU (SD=1.03), and 1.84 drugs for maximum SPU (SD=1.27). The most commonly used drugs included the following: alcohol (the most widely used substance, with 97.8% of participants drinking at least once during the past 12 months, 81.0% drinking at least once simultaneously on a usual occasion, and 84.6% drinking at least once simultaneously on occasions where they combined a maximum of various drugs), tobacco (49.8% CPU, 44.0% to 56.5% SPU), and cannabis (32.1% CPU, 15.4% to 29.2% SPU). Crystal meth, heroin, ketamine, GHB/GBL, research chemicals, and spice were the least commonly used drugs (0.3% to 0.5% CPU, 0.0% to 0.2% SPU).

Table 1 Prevalence rates for each drug for CPU, usual SPU, and maximum SPU.

	% of users		
	CPU	Usual SPU	Maximum SPU
Alcohol	97.8	81.0	84.6
Tobacco	49.8	44.0	56.5
Cannabis	32.1	15.4	29.2
Hallucinogens/magic mushrooms	2.7	0.3	1.1
Other hallucinogens	2.3	0.5	1.3
Salvia divinorum	2.1	0.2	0.8
Speed	2.7	0.7	1.6
Amphetamine/methamphetamines	1.9	0.5	0.9
Crystal meth	0.3	0.1	0.1
Poppers	2.6	0.3	0.8
Inhalants	2.2	0.2	0.6
Ecstasy	3.8	1.1	2.6
Cocaine	3.3	0.9	2.4
Heroin	0.3	0.1	0.1
Ketamine	0.5	0.0	0.2
GHB/GBL	0.4	0.1	0.2
Research chemicals	0.3	0.0	0.1
Spice	0.5	0.0	0.1

For example, 97.8% of the participants used alcohol concurrently during the past 12 months, whereas only 0.5% used spice concurrently during the past 12 months. On a usual occasion, 81.0% of the participants drank alcohol simultaneously with another substance, and only 0.1% of them used heroin simultaneously with another substance.

CPU and SPU patterns

Cross tables displaying the calculated CPU and maximum SPU values for each drug were presented. Cross tables were not presented for usual SPU because of the small sample size obtained for some drugs. The results for CPU are shown in Table 3. Participants using only one drug, predominantly consumed alcohol (97.4%). When two types of drugs were used, it was most commonly alcohol (98.6%) and tobacco (78.3%). When three drugs were used, cannabis was added to alcohol and tobacco (94.3%). When four to seven types of drugs were used as CPU, hallucinogens (magic mushrooms, other hallucinogens, salvia divinorum), uppers (ecstasy, cocaine, speed amphetamines/methamphetamines), and sniffed drugs (poppers and solvents) were incorporated. Finally, when eight or more types of drugs were used, spice, crystal meth, heroin, GHB/GBL, research chemicals, and ketamine were the choice substances to be added. Commonly, these "later stage" drugs (i.e., spice, crystal meth, heroin, GHB/GBL, research chemicals, and ketamine) were added without replacing "early stage" drugs.

The results for maximum SPU were similar to CPU (Table 4). The first association was alcohol and tobacco (among the participants who reported the use of two drugs simultaneously, 98.7% used alcohol and 89.9% used tobacco), which were combined with cannabis when three types of drugs were used at the same time. When four to five types of drugs were used simultaneously, hallucinogens (magic mushrooms, other hallucinogens, salvia divinorum), uppers (ecstasy, cocaine, speed amphetamines/methamphetamines), and sniffed drugs (poppers and solvents) were added to those drugs already being used. Spice, crystal meth, heroin, GHB/GBL, research chemicals, and ketamine were incorporated when six or more types of drugs were used. As with CPU, if additional drugs were simultaneously used, then participants commonly added them without replacing other drugs that were already being used.

Table 2 Descriptive statistics for polydrug use and outcomes.

	Mean	SD
CPU (1–18)	2.07	1.48
SPU usual (0–18)	1.46	1.03
SPU maximum (0–18)	1.84	1.27
Social consequences (0–1)	0.22	0.21
Health consequences (0–1)	0.17	0.19
Depression (0–5)	0.69	0.70
Aggressiveness (0–1)	0.42	0.21
Anxiety (0–1)	0.20	0.20
Mental health (0–100)[a]	47.36	9.01
Physical health (0–100)[a]	53.11	6.26

Remarks: Ranges are given in brackets, SD: standard deviation.
[a]A higher score indicated better health, in contrast to the other variables in the table. Here, 50 is the standardized mean.

Associations of SPU with mental, social, and physical factors

The results for the models of usual and maximum SPU associations, with and without taking CPU into account, are shown in Table 5. In the unadjusted model, usual SPU was associated with all 7 dependent variables, whereas maximum SPU was associated with 6 out of the 7 dependent variables. When participants used more substances simultaneously, they also felt more depressed (β=0.124 to 0.136, $p<0.001$), anxious (β=0.053 to 0.064, $p<0.001$), and aggressive (β=0.147 to 0.182, $p<0.001$). In addition, they had a poorer state of mental health (β=−0.113 to −0.098, $p<0.001$), and reported more negative social (β=0.290 to 0.304, $p<0.001$) and health (β=0.088 to 0.109, $p<0.001$) consequences. There was also a negative association between

Table 3 Percentages of each drug use according to the number of CPU.

	CPU – number of drugs used								
	1 n=2341	2 n=1459	3 n=1077	4 n=199	5 n=72	6 n=58	7 n=39	8 n=22	9 and more n=52
Alcohol	97.4	98.6	99.9	98.5	100	100	100	100	94.2
Tobacco	2.2	78.3	96.5	98.0	97.2	96.6	97.4	100	90.4
Cannabis	0.3	19.5	94.3	91.5	98.6	94.8	92.3	100	86.5
Poppers	0.0	1.3	1.8	19.6	20.8	22.4	17.9	13.6	42.3
Hallucinogens/magic mushrooms	0.0	0.3	0.8	17.1	23.6	34.5	43.6	40.9	69.2
Salvia divinorum	0.0	0.2	0.5	17.1	19.4	13.8	30.8	31.8	61.5
Ecstasy	0.0	0.1	0.9	14.1	33.3	63.8	74.4	100	96.2
Cocaine	0.0	0.1	1.1	12.1	33.3	55.2	59.0	59.1	90.4
Solvent sniffing	0.0	1.4	2.4	11.6	20.8	17.2	12.8	9.1	28.8
Speed	0.0	0.0	0.8	6.5	16.7	36.2	61.5	68.2	94.2
Other hallucinogens	0.0	0.1	0.3	3.5	15.3	37.9	46.2	77.3	82.7
Amphetamine/methamphetamines	0.0	0.0	0.2	5.5	13.9	13.8	41.0	54.5	84.6
Spice	0.0	0.1	0.1	1.5	2.8	6.9	7.7	4.5	19.2
Chrystal meth	0.0	0.1	0.1	0.0	1.4	0.0	2.6	13.6	19.2
Heroin	0.0	0.0	0.0	0.5	1.4	0.0	0.0	4.5	25.0
GHB/GBL	0.0	0.0	0.2	1.0	0.0	1.7	0.0	13.6	28.8
Research chemicals	0.0	0.0	0.1	1.0	0.0	3.4	5.1	4.5	19.2
Ketamine	0.0	0.0	0.0	1.0	1.4	1.7	7.7	4.5	34.6

For example, among the participants who used 1 drug concurrently (n=2341), 97.4% drank alcohol, 2.2% smoked tobacco, 0.3% used cannabis, and 0.1% used solvent.

physical health and usual SPU (β=−0.052, p<0.001). In the adjusted models, SPU also had an additive association with aggressiveness (β=0.058 to 0.115, p<0.001) and negative social consequences (β=0.098 to 0.110, p<0.001). However, SPU was no longer negatively associated with depression, anxiety, health consequences, or mental/

Table 4 Column percentages of each drug use according to the number of maximum SPU drug use.

	Maximum SPU – number of drugs used					
	2 n=1734	3 n=1159	4 n=153	5 n=47	6 n=40	7 and more n=36
Alcohol	98.7	99.1	98.7	97.9	97.5	94.4
Tobacco	89.9	98.4	98.0	95.7	97.5	94.4
Cannabis	10.5	95.7	90.8	100	97.5	100
Ecstasy	0.1	1.3	22.2	53.2	75.0	94.4
Cocaine	0.2	1.4	19.6	53.2	60.0	77.8
Hallucinogens/magic mushrooms	0.1	0.5	14.4	10.6	17.5	44.4
Others hallucinogens	0.1	0.5	12.4	14.9	27.5	61.1
Salvia divinorum	0.0	0.3	13.1	12.8	10.0	25.0
Poppers	0.2	0.7	12.4	10.6	10.0	13.9
Speed	0.1	0.7	5.9	25.5	67.5	72.2
Solvent sniffing	0.1	1.1	5.2	4.3	7.5	13.9
Amphetamine/methamphetamines	0.1	0.1	2.6	14.9	22.5	69.4
GHB/GBL	0.0	0.0	0.7	0.0	5.0	22.2
Research chemicals	0.0	0.1	1.3	0.0	2.5	8.3
Ketamine	0.0	0.1	2.0	2.1	2.5	13.9
Spice	0.1	0.1	0.7	2.1	0.0	11.1
Crystal meth	0.1	0.0	0.0	0.0	0.0	5.6
Heroin	0.0	0.0	0.0	2.1	0.0	16.7

For example, among the participants who used 2 drugs simultaneously (n=1734), 98.7% drank alcohol, 89.9% smoked tobacco, 10.5% used cannabis, 0.2% used cocaine, 0.2% used poppers, and 0.1% used ecstasy, hallucinogens such as magic mushrooms, other hallucinogens, speed, solvent, amphetamines/methamphetamines, spice, and crystal meth.

Table 5 Standardized slopes (β) of regression analyses for unadjusted and adjusted models of health issues on SPU.

Outcomes	SPU (unadjusted)		Residuals from CPU models (adjusted)	
	Usual β (SE)	Maximum β (SE)	Usual β (SE)	Maximum β (SE)
Social consequences	0.290 (0.003)[a]	0.304 (0.002)[a]	0.110 (0.004)[a]	0.098 (0.003)[a]
Health consequences	0.088 (0.014)[a]	0.109 (0.14)[a]	0.011 (0.013)	0.025 (0.014)
Aggressiveness	0.182 (0.014)[a]	0.147 (0.014)[a]	0.115 (0.014)[a]	0.058 (0.014)[a]
Anxiety	0.064 (0.014)[a]	0.053 (0.014)[a]	0.021 (0.014)	−0.004 (0.013)
Physical health	−0.052 (0.014)[a]	−0.034 (0.014)	−0.020 (0.014)	0.012 (0.013)
Mental health	−0.098 (0.014)[a]	−0.113 (0.014)[a]	−0.011 (0.014)	−0.013 (0.014)
Depression	0.124 (0.014)[a]	0.136 (0.014)[a]	0.021 (0.014)	0.014 (0.013)

Remarks: Standardized standard errors (SE) are given in parentheses.

[a]$p<0.001$; p-values with a Holm-Bonferroni correction are given.

physical health. The remaining associations were not as strong as those of the unadjusted models (e.g., aggressiveness: $\beta=0.147$ for maximum SPU and $\beta=0.058$ for residuals of maximum SPU).

Discussion

Patterns of CPU and SPU

This study investigated the patterns of CPU and SPU by examining separate cross tables for CPU and maximum SPU with each drug. The results indicated that drugs were commonly added for both CPU and maximum SPU. When participants increased the number of drugs they were using, they usually did not replace one drug with another. Instead, they added more drugs to those that were already in use. The order in which drugs were added resembled the sequential drug use patterns described in previous studies, with licit drugs (alcohol and tobacco) used initially, followed by cannabis and then other illicit drugs (39–42). Apart from cannabis, the use of two distinct classes of illicit drugs was identified. The drugs used first included hallucinogens (magic mushrooms), other hallucinogens (LSD or salvia divinorum), uppers (speed, ecstasy, cocaine, amphetamines, or methamphetamines), and sniffed drugs (poppers or solvents). The use of these substances was followed by use of other "hard" drugs, such as ketamine, heroin, GHB/GBL, research chemicals, crystal meth, and spice. In fact, it appeared that there was an escalation in the types of illicit drugs being used. In other words, the number of drugs used can be considered as an indicator of the severity of polydrug use. This result supported the use of "total number of drugs" as a relevant variable, as an increasing number of drugs added information (i.e., additional drugs to those already used), but was not something qualitatively different (e.g., other drugs instead of those already used).

Associations of SPU with mental, social, and physical factors

Regression analyses showed that CPU was a confounding variable for SPU. When the models were not adjusted for CPU, SPU showed an association with all factors related to mental, social, and physical consequences (except physical health with SPU maximum). When the variance between CPU and SPU was taken into account, the only remaining associations were aggressiveness and negative social consequences (for both usual and maximum SPU). In other words, the number of drugs used concurrently had an important association with health factors. This agreed with results reported in previous studies (15–18). Aggressiveness and social consequences are interrelated. Therefore, this finding might also suggest that only SPU can display this independent association among a subgroup of individuals prone to these types of behavioral disorders. There was no significant association between SPU and depression, anxiety, or mental/physical health consequences when CPU was taken into account. These results were interesting as they may indicate that users understood the pharmacology of the drugs they used, combining them intentionally to reduce undesired effects (20, 43, 44). Indeed, some associations are well known [e.g., alcohol reduces the discomfort of coming down from cocaine (26, 45), and cocaine attenuates the negative effects of alcohol (26)]. In addition, heroin can be used when coming down from cocaine to attenuate its anxiogenic effects, whereas cocaine can be used to temper the depressive effects of heroin (46). Thus, the absence

of association between SPU and depression, anxiety, or mental health may be explained by users' intention to combine drugs in order to avoid particular detrimental effects, such as depression and anxiety. Other explanations could be that the number of drugs used accounts for associations with health/consequences, and that combined simultaneous use does not add more to this association. This would mean that measuring the solely number of drugs used, and not necessarily their simultaneous use, may be sufficient in substance use surveys. Further investigations must be conducted to test these two hypotheses.

Limitations

The main limitation of this study was its cross-sectional design, which did not allow a conclusion to be made on whether polydrug use was a cause or a consequence of health, mental, and social problems, as is often the case in these types of studies (47, 48). However, C-SURF is a longitudinal study, and future analyses must focus on studying the effect of past drug use on current psychological distress. Another limitation of our study was that it did not include female participants. Thus, associations between polydrug use and health factors should be studied in a sample of women, in order to assess the potential differences between men and women with regard to these findings. A third limitation involved the use of a personality scale to assess anxiety and aggressiveness. Although this scale can be employed to examine the level of anxiety or aggressiveness at a given time point, further studies using questions more closely related to psychological health or distress are needed.

Conclusion

We demonstrated that the pattern of CPU and SPU within a sample of young adult men followed previously described stages of drug use, which involved the sequential use of alcohol, tobacco, cannabis, and then other illicit drugs. In addition, two distinct classes of illicit drugs were identified. The first class included uppers, hallucinogens and sniffed drugs, whereas the second class included ketamine, heroin, GHB/GBL, research chemicals, crystal meth, and spice. As the users progressed along this sequence of drug use, they did not stop taking any of the drugs that they were already using. Hence, the number of drugs used can be seen as a proxy of the severity of polydrug use.

The additive effect of SPU on CPU was also assessed in this study. Previous reports indicated that SPU can be distinguished from CPU. Thus, even though these two concepts were linked, they remained discriminable constructs (19). Consistent with this idea, we found that SPU was independently associated with social factors, including aggressiveness and negative social consequences among young men. However, we did not observe any relevant associations with some specific outcomes related to mental health, such as depression or anxiety.

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References

1. Barrett SP, Darredeau C, Pihl RO. Patterns of simultaneous polysubstance use in drug using university students. Hum Psychopharmacol 2006;21:255–63.
2. Somers JM, Goldner EM, Waraich P, Hsu L. Prevalence studies of substance – related disorders: a systematic review of the literature. Can J Psychiatry 2004;49:373–84.
3. Brache K, Stockwell T, Macdonald S. Functions and harms associated with simultaneous polysubstance use involving alcohol and cocaine. J Subst Use 2012;17:399–416.
4. Ball JC, Ross A. The effectiveness of methadone maintenance treatment: patients, programs, services, and outcome. Softcover reprint of the original, 1st ed. (1991). London: Springer, 2011.
5. Darke S, Hall W. Levels and correlates of polydrug use among heroin users and regular amphetamine users. Drug Alcohol Depend 1995;39:231–5.
6. Hammersley R, Forsyth A, Lavelle T. The criminality of new drug users in Glasgow. Br J Addict 1990;85:1583–94.
7. Hubbard RL, Gail S, Flynn PM, Anderson J, Etheridge RM. Overview of 1-year follow-up outcomes in the Drug Abuse Treatment Outcome Study (DATOS). Psychol Addict Behav 1997;11:261–78.
8. Collins RL, Ellickson PL, Bell RM. Simultaneous polydrug use among teens: prevalence and predictors. J Subst Abuse 1998;10:233–53.
9. Beswick T, Best D, Rees S, Coomber R, Gossop M, Strang J. Multiple drug use: patterns and practices of heroin and crack use in a population of opiate addicts in treatment. Drug Alcohol Rev 2001;20:201–4.
10. Booth BM, Leukefeld C, Falck R, Wang J, Carlson R. Correlates of rural methamphetamine and cocaine users: results from a multistate community study. J Stud Alcohol 2006;67:493–501.
11. Malcolm BP, Hesselbrock MN, Segal B. Multiple substance dependence and course of alcoholism among Alaska native men and women. Subst Use Misuse 2006;41:729–41.

12. Patterson TL, Semple SJ, Zians JK, Strathdee SA. Methamphetamine-using HIV-positive men who have sex with men: correlates of polydrug use. J Urban Health 2005;82:120–6.
13. John D, Kwiatkowski CF, Booth RE. Differences among out-of-treatment drug injectors who use stimulants only, opiates only or both: implications for treatment entry. Drug Alcohol Depend 2001;64:165–72.
14. Petry NM. The effects of housing costs on polydrug abuse patterns: a comparison of heroin, cocaine, and alcohol abusers. Exp Clin Psychopharmacol 2001;9:47–58.
15. Hakansson A, Schlyter F, Berglund M. Associations between polysubstance use and psychiatric problems in a criminal justice population in Sweden. Drug Alcohol Depend 2011;118:5–11.
16. Darke S, Ross J. Polydrug dependence and psychiatric comorbidity among heroin injectors Drug Alcohol Depend 1997;48:135–41.
17. Borges G, Walters EE, Kessler RC. Associations of substance use, abuse, and dependence with subsequent suicidal behavior. Am J Epidemiol 2000;151:781–9.
18. Brådvik L, Berglund M, Frank A, Lindgren A, Löwenhielm P. Number of addictive substances used related to increased risk of unnatural death: a combined medico-legal and case-record study. BMC Psychiatry 2009;9:1–7.
19. Earleywine M, Newcomb MD. Concurrent versus simultaneous polydrug use: prevalence, correlates, discriminant validity, and prospective effects on health outcomes. Exp Clin Psychopharmacol 1997;5:353–64.
20. Martin CS. Timing of alcohol and other drug use. Alcohol Res Health 2008;31:96–9.
21. McCabe SE, Cranford JA, Morales M, Young A. Simultaneous and concurrent polydrug use of alcohol and prescription drugs: prevalence, correlates, and consequences. J Stud Alcohol 2006;67:529–37.
22. Barrett SP, Gross SR, Garand I, Pihl RO. Patterns of simultaneous polysubstance use in Canadian rave attendees. Subst Use Misuse 2005;40:1525–37.
23. Olthuis JV, Darredeau C, Barrett SP. Substance use initiation: the role of simultaneous polysubstance use. Drug Alcohol Rev 2013;32:67–71.
24. Pape H, Rossow I, Storvoll EE. Under double influence: assessment of simultaneous alcohol and cannabis use in general youth populations. Drug Alcohol Depend 2009;101:69–73.
25. Midanik LT, Tam TW, Weisner C. Concurrent and simultaneous drug and alcohol use: results of the 2000 National Alcohol Survey. Drug Alcohol Depend 2007;90:72–80.
26. Decorte T. The taming of cocaine: cocaine use in European and American cities. VUB University Press, 2000.
27. Brière FN, Fallu JS, Descheneaux A, Janosz M. Predictors and consequences of simultaneous alcohol and cannabis use in adolescents. Addict Behav 2011;36:785–8.
28. Studer J, Baggio S, Mohler-Kuo M, Dermota P, Gaume J, et al. Examining non-response bias in substance use research- are late respondents proxies for non-respondents? Drug Alcohol Depend 2013;132:316–23.
29. Aluja A, Rossier J, García LF, Angleitner A, Kuhlman M, et al. A cross-cultural shortened form of the ZKPQ (ZKPQ-50-cc) adapted to English, French, German, and Spanish languages. Pers Indiv Differ 2006;41:619–28.
30. Bech P, Rasmussen NA, Olsen LR, Noerholm V, Abildgaard W. The sensitivity and specificity of the major depression inventory, using the present state examination as the index of diagnostic validity. J Affect Disord 2001;66:159–64.
31. Olsen LR, Jensen DV, Noerholm V, Martiny K, Bech P. The internal and external validity of the major depression inventory in measuring severity of depressive states. Psychol Med 2003;33:351–6.
32. Ware J Jr., Kosinski M, Keller SD. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. Med Care 1996;34:220–33.
33. Hibell B, Guttermsson U, Ahlström S, Balakireva O, Bjanason T, et al. The 2011 ESPAD report – substance use among students in 36 European countries. Stockholm: ESPAD, 2012.
34. Bucholz KK, Cadoret R, Cloninger CR, Dinwiddie SH, Hesselbrock VM, et al. A new, semi-structured psychiatric interview for use in genetic linkage studies: a report on the reliability of the SSAGA. J Stud Alcohol 1994;55:149–58.
35. Hesselbrock M, Easton C, Bucholz KK, Schuckit M, Hesselbrock V. A validity study of the SSAGA – a comparison with the SCAN. Addiction 1999;94:1361–70.
36. Wechsler H, Davenport A, Dowdall G, Moeykens B, Castillo S. Health and behavioral consequences of binge drinking in college. A national survey of students at 140 campuses. J Am Med Assoc 1994;272:1672–7.
37. Holm S. A simple sequentially rejective multiple test procedure. Scand J Stat 1979;6:65–70.
38. Kim RS. Standardized regression coefficients as indices of effect sizes in meta-analysis. Florida: Florida State University, 2011.
39. Kandel D. Stages in adolescent involvement in drug use. Science 1975;190:912–4.
40. Kandel DB. Examining the gateway hypothesis stages and pathways of drug involvement. Stages and pathways of drug involvement: examining the gateway hypothesis. New York: Cambridge University Press, 2002.
41. Kandel DB, Yamaguchi K, Klein LC. Testing the gateway hypothesis. Addiction 2006;101:470–2; discussion 4–6.
42. Scholey AB, Parrott AB, Buchanan T, Heffernan TM, Ling J, et al. Increased intensity of ecstasy and polydrug usage in the more experienced recreational Ecstasy/MDMA users: a WWW study. Addict Behav 2004;29:743–52.
43. Merchand J, MacDonald R. Youth and rave culture: ecstasy and health. Youth Policy 1994;45:16–37.
44. Uys JDK, Niesink RJM. Pharmacological aspects of the combined use of 3,4-methylenedioxymethamphetamine (MDMA, ecstasy) and gamma-hydroxybutyric acid (GHB): a review of the literature. Drug Alcohol Rev 2005;24:359–68.
45. Pennings EJM, Leccese AP, Wolff FAd. Effects of concurrent use of alcohol and cocaine. Addiction 2002;97:773–83.
46. Leri F, Bruneau J, Stewart J. Understanding polydrug use: review of heroin and cocaine co-use. Addiction 2003;98:7–22.
47. Boyd CJ, McCabe SE. Coming to terms with the nonmedical use of prescription medications. Subst Abuse Treat Prev Policy 2008;3:1–3.
48. Zullig KJ, Divin AL. The association between non-medical prescription drug use, depressive symptoms, and suicidality among college students. Addict Behav 2012;37:890–9.